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DETAILED REQUIREMENTS DOCUMENT
FOR THE
BALLOON-BORNE ULTRAVIOLET STELLAR
SPECTROMETER DECOMMUTATION AND
FORMATTING PROGRAMS

Job Order 83-157

(NASA-CR-144566) DETAILED REQUIREMENTS
DOCUMENT FOR THE BALLOON-BORNE ULTRAVIOLET
STELLAR SPECTROMETER DECOMMUTATION AND
FORMATTING PROGRAMS (Lockheed Electronics
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For

INSTITUTIONAL DATA SYSTEMS DIVISION



National Aeronautics and Space Administration
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14. SUBJECT TERMS <table style="width: 100%; border: none;"> <tr> <td style="border-bottom: 1px solid black; width: 33%;">Balloon-borne</td> <td style="border-bottom: 1px solid black; width: 33%;">Ultraviolet</td> <td style="border-bottom: 1px solid black; width: 33%;"></td> </tr> <tr> <td style="border-bottom: 1px solid black;">Stellar</td> <td style="border-bottom: 1px solid black;">Decommutation</td> <td style="border-bottom: 1px solid black;"></td> </tr> <tr> <td style="border-bottom: 1px solid black;">Spectrometer</td> <td style="border-bottom: 1px solid black;">Formatting</td> <td style="border-bottom: 1px solid black;"></td> </tr> </table>			Balloon-borne	Ultraviolet		Stellar	Decommutation		Spectrometer	Formatting	
Balloon-borne	Ultraviolet										
Stellar	Decommutation										
Spectrometer	Formatting										

FOREWORD

This Detailed Requirements Document defines requirements for programs to format test data obtained by the Balloon-Borne Ultraviolet Stellar Spectrometer equipment to be used in joint experiments with the Netherlands. It has been prepared by personnel of the Data Processing Systems Department, Lockheed Electronics Company, Inc., (LEC), in response to a request by the Institutional Data Systems Division (IDSD), Data Processing Branch of the National Aeronautics and Space Administration.

CONTENTS

Section	Page
1. PURPOSE AND SCOPE.	1-1
2. OVERVIEW	2-1
2.1 <u>BACKGROUND</u>	2-1
2.1.1 OBJECTIVES.	2-1
2.1.2 RESPONSIBILITIES.	2-2
2.1.3 REFERENCES.	2-2
2.2 <u>GENERAL DESCRIPTION</u>	2-2
3. SCIENCE DATA DECOMMUTATION PROGRAM REQUIREMENTS	3-1
3.1 <u>INPUT REQUIREMENTS</u>	3-1
3.2 <u>PROCESSING REQUIREMENTS</u>	3-3
3.3 <u>OUTPUT REQUIREMENTS</u>	3-4
3.3.1 SBS TAPE.	3-4
3.3.2 CONSOLE TYPEWRITER LOG.	3-4
4. SBS REFORMAT PROGRAM REQUIREMENTS.	4-1
4.1 <u>INPUT REQUIREMENTS</u>	4-1
4.1.1 SCIENCE DATA SBS TAPE	4-1
4.1.2 ENGINEERING AND HOUSEKEEPING DATA SBS TAPE.	4-1
4.1.3 CONTROL INFORMATION	4-4
4.2 <u>PROCESSING REQUIREMENTS</u>	4-4

Section	Page
4.3 <u>OUTPUT REQUIREMENTS</u>	4-4
4.3.1 SCIENCE DATA.	4-4
4.3.2 SRL ENGINEERING AND HOUSEKEEPING DATA . .	4-8
4.3.3 QUALITY CONTROL OUTPUT.	4-8
5. GENERAL TEST APPROACH.	5-1
6. PRODUCTION IMPLEMENTATION.	6-1
APPENDIX	
A. ASCII CODE CHARACTER SET	A-1

FIGURES

Figure		Page
2-1	Data flow for BUSS processing.	2-3
3-1	Example of the PCM format.	3-2
4-1	BAPS8 SBS tape format.	4-2
4-2	PESD science data seven-track digital tape format.	4-6
4-3	SRL science data nine-track digital tape format.	4-7
4-4	SRL engineering and housekeeping nine-track digital tape format	4-9

ABBREVIATIONS AND ACRONYMS

ASCII	American Standard Code for Information Interchange
BAPS8	Balloon Astral Pointing System 8
bpi	Bits per inch
BUSS	Balloon-Borne Stellar Spectrometer
CDC	Control Data Corporation
HP	Hewlett Packard
IDSD	Institutional Data System Division
kb	Kilobit
LEC	Lockheed Electronics Company
LSB	Least Significant Bit
MSB	Most Significant Bit
PCM	Pulse Coded Modulation
PDC	Programmed Data Channel
PESD	Planetary and Earth Science Division
RTS	Real-Time Scope
SBS	Serial Bit Stream
SRL	Space Research Laboratory

1. PURPOSE AND SCOPE

The purpose of this document is to define the requirements for developing a decommutation and a data reformat program to process test data obtained by the Balloon-Borne Ultraviolet Stellar Spectrometer (BUSS) used in a joint experiment with the Space Research Laboratory (SRL) in the Netherlands. Output tapes produced for the SRL will be compatible with the Hewlett Packard (HP) 2100 computer used at the Netherlands installation.

2. OVERVIEW

2.1 BACKGROUND

The Balloon-Borne Ultraviolet Stellar Spectrometer (BUSS) flights provide a space environment in which to test the instrumentation proposed for use onboard the Space Shuttle. During Fiscal 1976, the United States and the Netherlands will launch the first of several balloon flights for a collaboration in ultraviolet space research. This work will also provide experience needed for the Space Shuttle flights and promote international cooperation in space astronomy research.

The experiments will be carried aloft by balloons launched from the Palestine, Texas, launch facility. Experimental data will be transmitted to Earth by an onboard Pulse Coded Modulation (PCM) transmitting system. A 48,000 bit-per-second system is to record spectrometer science data and an 8,000 bit-per-second system to record the housekeeping and engineering data. Data are recorded at a mobile ground station on 1-inch analog tapes.

2.1.1 OBJECTIVES

The objectives of this task are to provide the SRL with HP2100 computer compatible tapes of science and engineering data and to produce a science data tape for the Planetary and Earth Sciences Division (PESD) in a format compatible with a PDP-8/E computer.

To accomplish these objectives, two new processing programs will be developed. One will be a decommutation program on the Control Data Corporation (CDC) 3200 computer for the 48-kilobit science data. The other will be a reformat program for use on the UNIVAC 1108 computer to convert the Serial Bit Stream (SBS) tapes from the 48-kb decommutation program and the Balloon

Astral Pointing System (BAPS8) 8-kb decommutation program to a specified format for the SRL.

2.1.2 RESPONSIBILITIES

The Data Processing Systems Department of LEC has the responsibility of coordinating with the customer to define and document the requirements and to develop and implement the programs.

2.1.3 REFERENCES

The following reference material is related to these detailed requirements:

- NASA/LEC Task Agreement 19, Software Development for Balloon-Borne Ultraviolet Stellar Spectrometer (BUSS) Data Processing
- Job Order 83-157
- IDSD Serial Bit Stream Data Format Memorandum 71-FD56-324, dated December 14, 1971.
- Balloon-Borne Ultraviolet Stellar Spectrometer 1971-1977 JSC-09180

2.2 GENERAL DESCRIPTION

The BUSS processing data flow is shown in figure 2-1. Subsequent processing of the SBS engineering and housekeeping data tape is to be performed utilizing existing data conversion, data tabulation, and plot programs. The BAPS8 program for the CDC 3200 is also an existing program.

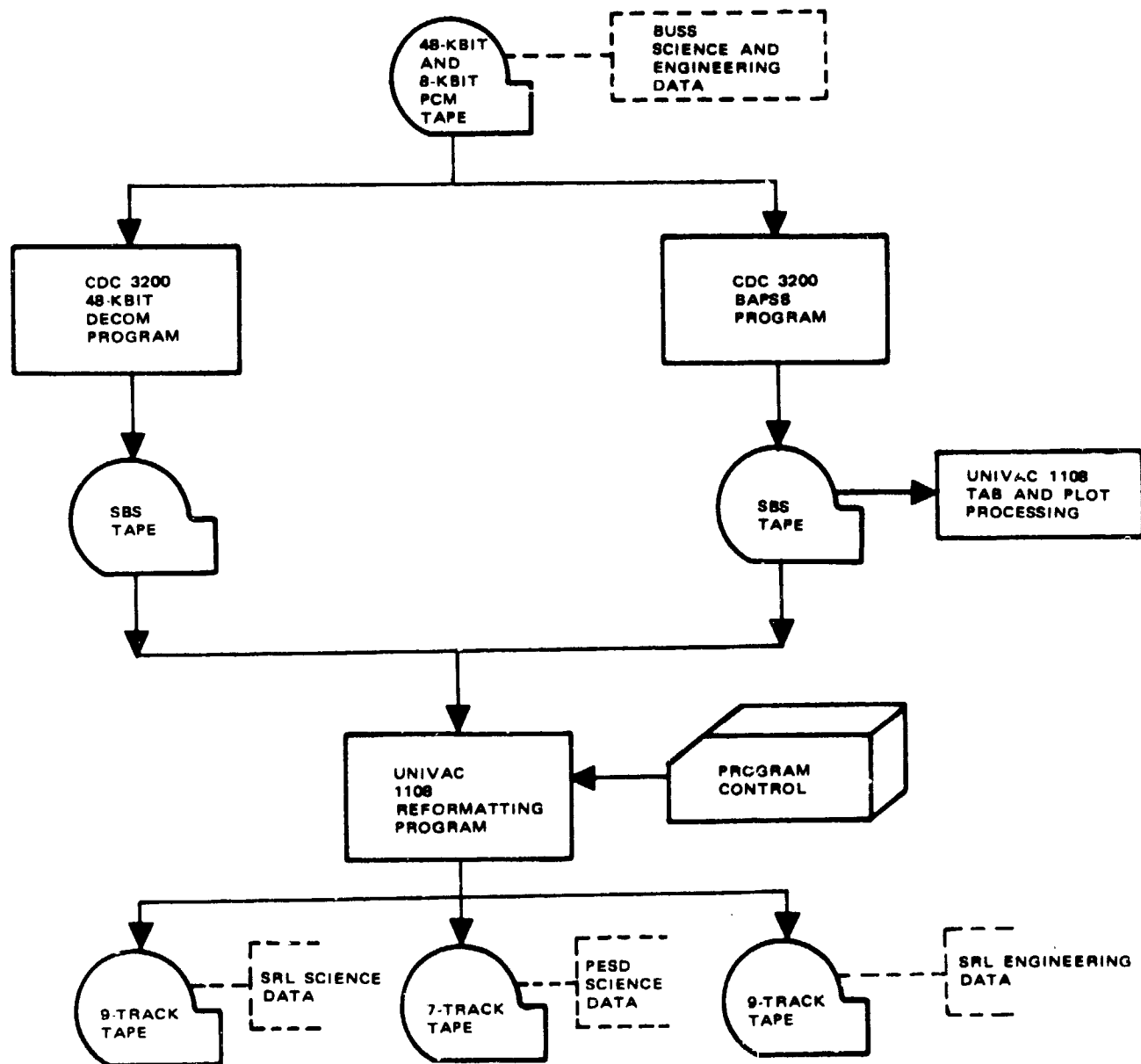


Figure 2-1. - Data flow for BUSS processing.

3. SCIENCE DATA DECOMMUTATION PROGRAM REQUIREMENTS

This program will be written in COMPASS for the CDC 3200 computer using the Real-Time Scope Operating System (RTS). It will format the data contained on a 1-inch analog PCM tape into a seven-track digital tape in SBS format.

3.1 INPUT

Input to the science data decommutation program is a Delayed Modulation-Mark (Miller) encoded 14-track PCM tape 1-inch wide recorded at 30 inches per second in the direct mode to yield a 48-kilobit rate. IRIG B timing and a 50-kilocycle reference will also be directly recorded on separate tracks. Data is recorded with the least significant bit first.

The PCM format (see figure 3-1) will consist of the following words, in chronological order:

- 32-bit synchronization word
- 16-bit line counter word
- 16-bit status word
- 1,016 eight-bit words scientific data (one raster)
- 32-bit check word
- 16-bit line counter word
- 16-bit status word

The last three items are repeated 16 times to form a total frame length of 1,152 eight-bit words.

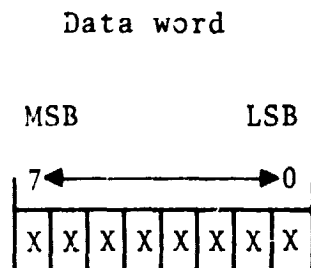
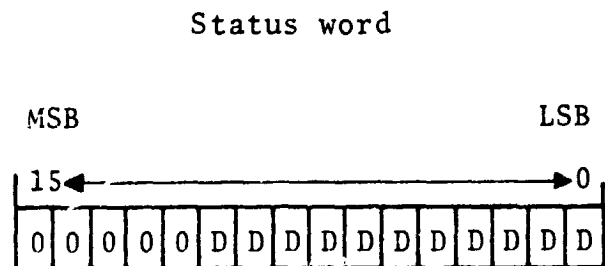
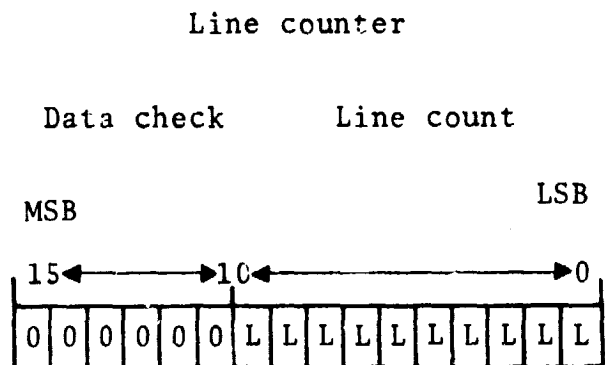
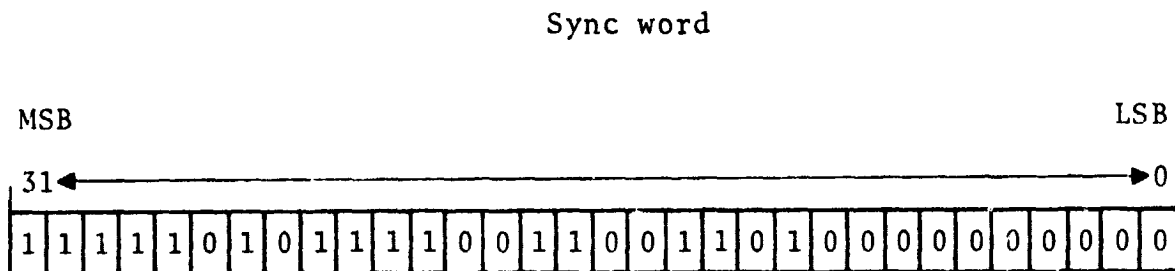


Figure 3-1. — Example of the PCM format.

The bits of the status word have the following meaning:

Bit 0 (LSB) - shutter open
Bit 1 - stepping motor
Bit 2 - heater and alignment on
Bit 3 - read-out high voltages on
Bit 4 - photocathode voltage on
Bit 5 - focus current on
Bit 6 - deflection on
Bit 7 - deflection normal
Bit 8 - target voltage read out
Bit 9 - target voltage erase
Bit 10 - erase lamp on
Bit 11 - spare
Bit 12 - spare
Bit 13 - spare
Bit 14 - spare
Bit 15 (MSB) - spare

3.2 PROCESSING REQUIREMENTS

The principle objective of the PCM decommutation program is to produce a SBS-formatted computer compatible tape containing PCM data from the 48-kilobit science data bit stream. In general the program must input data from the PCM subsystem, utilizing the CDC 3200 programmed data channel (PDC); input time code information from the timing subsystem; and output time and data in the SBS format providing for continuation reels if necessary. The program will optionally interrogate the line counter and the status word and accept data when any one of the following criteria is present:

- The 6 MSB's of the line counter (10 through 15) are all zeros.
- Bit 6 (deflection on) of the status word is on.
- Bit 7 (deflection normal) of the status word is on.

3.3 OUTPUT REQUIREMENTS

The program will output a SBS-formatted computer compatible tape and a console typewriter log.

3.3.1 SBS TAPE

The SBS tape format is defined in reference 3 in section 2.1.3 of this document. A data descriptor contained in file 1 of the SBS tape will be generated by the data descriptor generator program GENDES. The format of the cards comprising this deck may also be found in reference 3 section 2.1.3 of this document.

3.3.2 CONSOLE TYPEWRITER LOG

The console typewriter log will be used to output the following:

- Synchronization status
- Number of times program lost synchronization
- Number of frames processed
- Number of frames deleted as a result of status word check
- Number of output records written

4. SBS TAPE REFORMAT PROGRAM REQUIREMENTS

The SBS tape reformat program will be written in FORTRAN V for the UNIVAC 1108/1110 utilizing the EXEC 8 operating system. It will reformat the science data SBS tape to a special nine-track tape format for the SRL and a special seven-track tape format for the PESD. It will also reformat the engineering and housekeeping SBS tape created by the BAPS8 program to a special nine-track format for the SRL.

4.1 INPUT REQUIREMENTS

Input to the reformat program will consist of science data and engineering and housekeeping data SBS tapes and lead cards for program control.

4.1.1 SCIENCE DATA SBS TAPE

The format of the science data SBS tape is defined in reference 3 in section 2.1.3. Record length and format will be determined in the design phase of the decommutation program specified in section 3.

The SBS tape will conform to the following characteristics:

- Standard seven-track digital magnetic tape
- 800 bpi packing density
- Odd parity (binary mode)
- Buffered tape (non-FORTRAN written)
- Double end-of-file tape terminator

4.1.2 ENGINEERING AND HOUSEKEEPING DATA SBS TAPE

The format of the engineering and housekeeping SBS data tape is defined in reference 3 in section 2.1.3. The format is shown in figure 4-1.



4-2

The SBS tape will conform to the following characteristics:

- Standard seven-track digital magnetic tape
- 800 bpi packing density
- Odd parity (binary mode)
- Euffered tape (non-FORTRAN written)
- 486 24-bit words per record
- Double en -of-file tape terminator

This data tape contains two major blocks in each data record - the header block and the data block. The first two words of the header block describe days, year, and data quality. These three values appear once per record.

The time and synchronization sub-block of the header block are unique names that have specific meaning. Words 2 through 21 describe time in milliseconds. The time block is normally the time of day of the data recording read from one of the time code translators. Time 1 is associated with data block 1, time 2 is associated with data block 2, etc. Words 22 to 41 describe synchronization and index. Synchronization 1 through 4 are reserved for association with time 1 through 4. Synchronization 5 through 8 are reserved for prime frame (main frame) synchronization indicators corresponding to data block 1 through 4. Synchronization 9 through 12 are reserved for subframe synchronization of data stored depending on the INDEX 1 through 4 entries.

The next 20 frames consist of data blocks containing 10 48-bit words per frame recorded from the PCM bit stream.

4.1.3 CONTROL INFORMATION

Five input lead cards will be used to provide header record narrative contained on the output tapes defined in section 4.3. Information for program control will be determined in the design phase and contained in the Detailed Design Specification.

4.2 PROCESSING REQUIREMENTS

The processing performed by the reformat program consists of converting the SBS-formatted tapes produced by the decommutation programs to the special formats as described in the output requirements section 4.3 of this document. The capability must be provided to handle multireel SBS input tapes and output multireel reformatted tapes if necessary.

All data contained on the SBS tapes will be output to the reformatted seven and nine-track tapes. However, an option to limit the output on synchronization status should be provided.

4.3 OUTPUT REQUIREMENTS

The SBS tape reformat program will be required to output two digital tapes containing science data and one tape containing engineering and housekeeping data, plus quality control data.

4.3.1 SCIENCE DATA

Science data will be output in two different formats - a seven-track tape to be used by the PESD and a nine-track tape to be used by the SRL.

4.3.1.1 PESD Tape Format

The PESD tape will conform to the following characteristics:

- Standard seven-track digital magnetic tape
- 800 bpi packing density

- Odd parity (binary mode)
- Buffered tape (non-FORTRAN written)
- 341 36-bit words per record
- Single end-of-file on all but final tape
- Double end-of-file on the final tape

The required format of the records on the PESD tape is depicted graphically in figure 4-2. The tape format is designed so the tape can input into a PDP-8/E computer for further processing by PESD. The first record will contain identification data written in ASCII format and the remaining records will contain the scientific data written in binary.

4.3.1.2 SRL Tape Format

The SRL tape will conform to the following characteristics:

- Standard nine-track digital magnetic tape
- 800 bpi packing density
- Odd parity (binary mode)
- Buffered tape (non-FORTRAN written)
- 228 36-bit words per record
- Single end-of-file at the end of each observation (1024 rasters per observation)
- 10 observations per tape
- Double end-of-file at the end of each tape

The required format of the records on the SRL tape is depicted graphically in figure 4-3. The tape format has been designed so the data can be used as input to a HP 2100 computer for further processing by SRL facility in the Netherlands. The

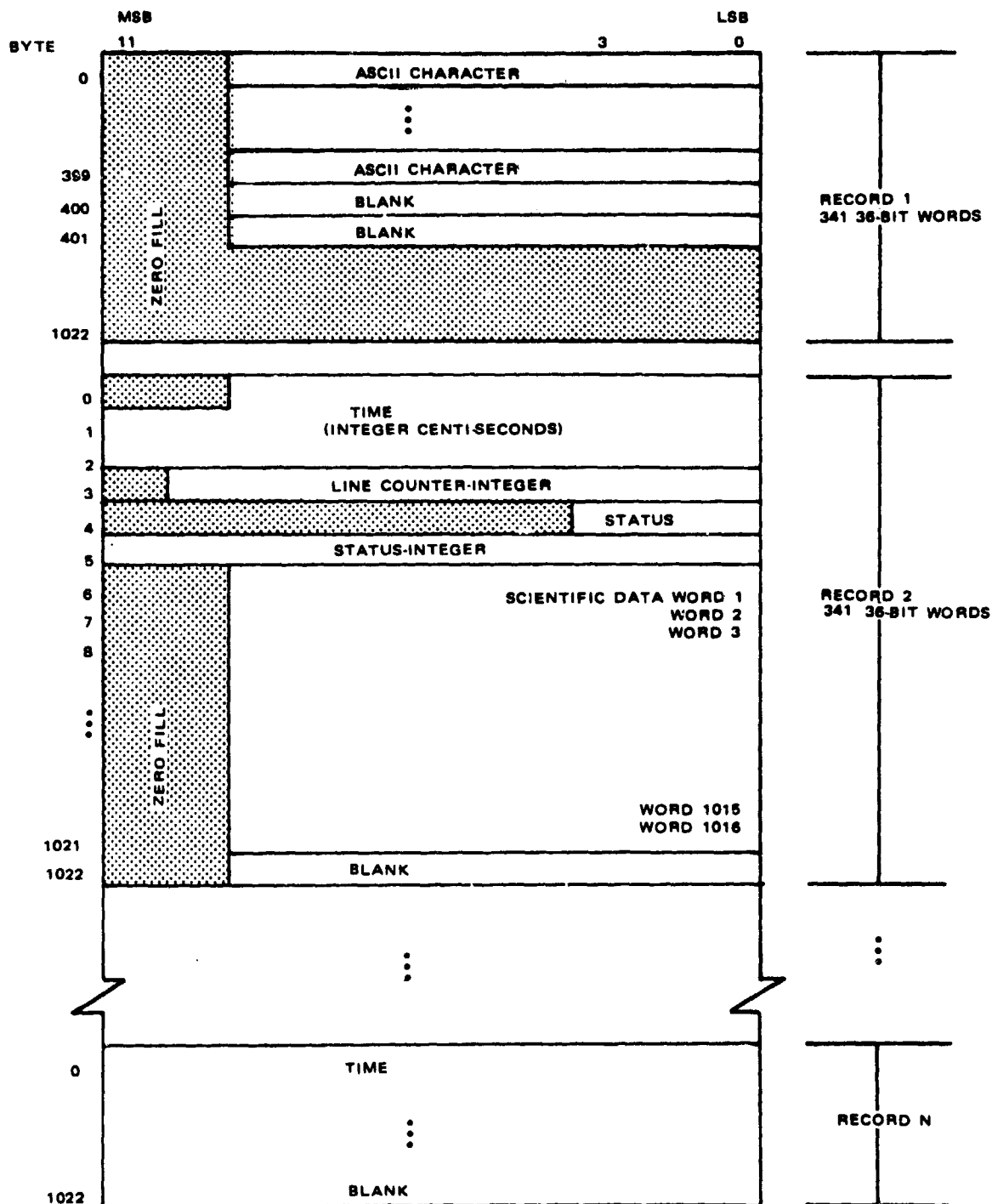


Figure 4-2. — PESD science data seven-track digital tape format.

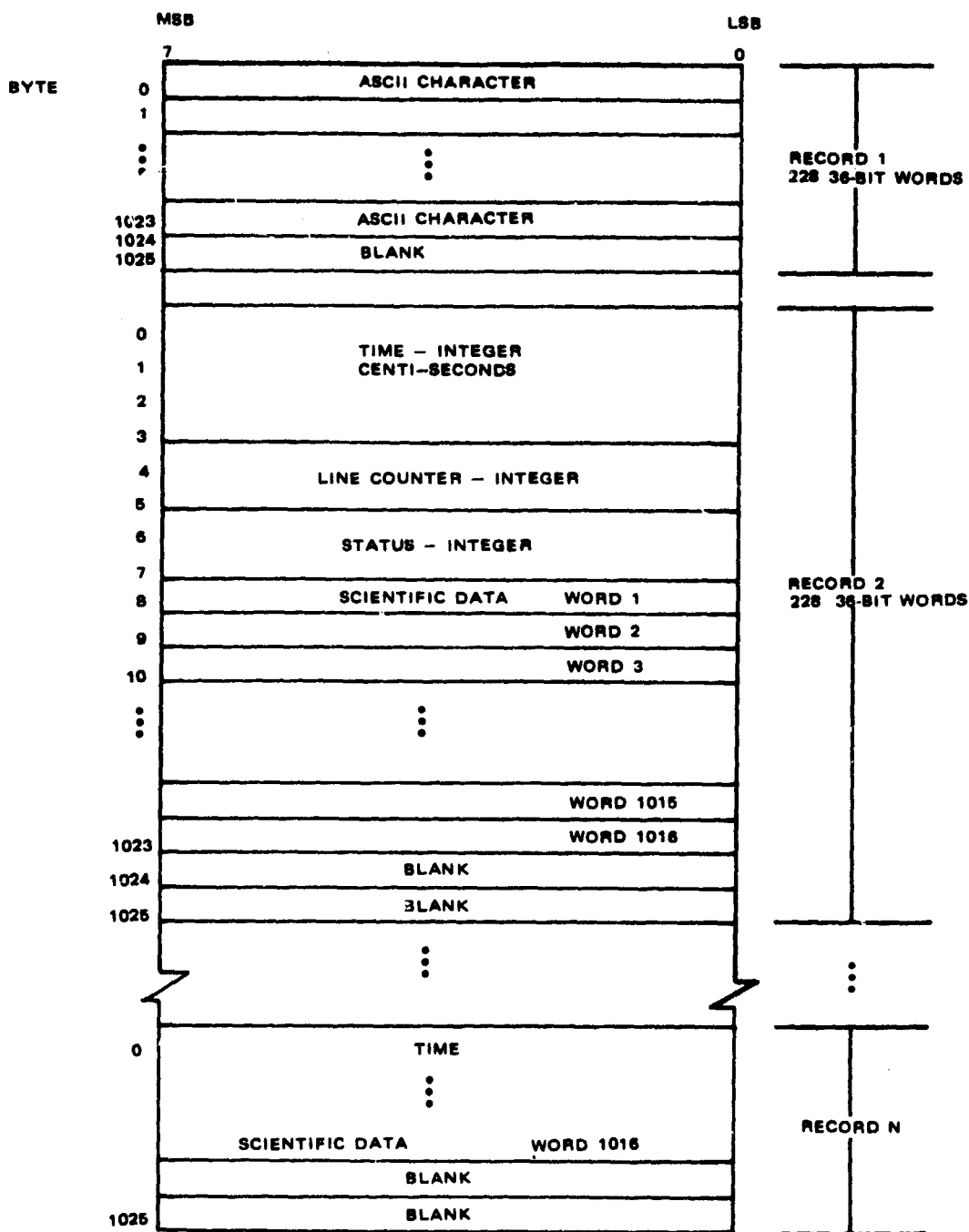


Figure 4-3. - SRL science data nine-track digital type format.

first record on the tape will contain identification data written in ASCII format and the remaining records will contain the scientific data.

4.3.2 SRL ENGINEERING AND HOUSEKEEPING DATA

Engineering and housekeeping data will be output on magnetic tape conforming to the following characteristics:

- Standard nine-track digital magnetic tape
- 800 bpi packing density
- Odd parity (binary mode)
- Buffered tape (non-FORTRAN written)
- 92 36-bit per word header record
- 1000 36-bit words per record data records
- Single end-of-file on all but the last tape
- Double end-of-file on the final tape

The required format of the records on the SRL engineering and housekeeping tape is depicted graphically in figure 4-4. The format has been designed so the data can be input to a HP 2100 computer by the SRL facility in the Netherlands. The first record will contain identification data written in ASCII format and the remaining records will contain the engineering and housekeeping data.

4.3.3 QUALITY CONTROL OUTPUT

Line printer output from the program will contain diagnostics of abnormalities encountered and information regarding processing activity. Items to be included must contain, but are not limited to the following:

- Program lead cards
- Record counts

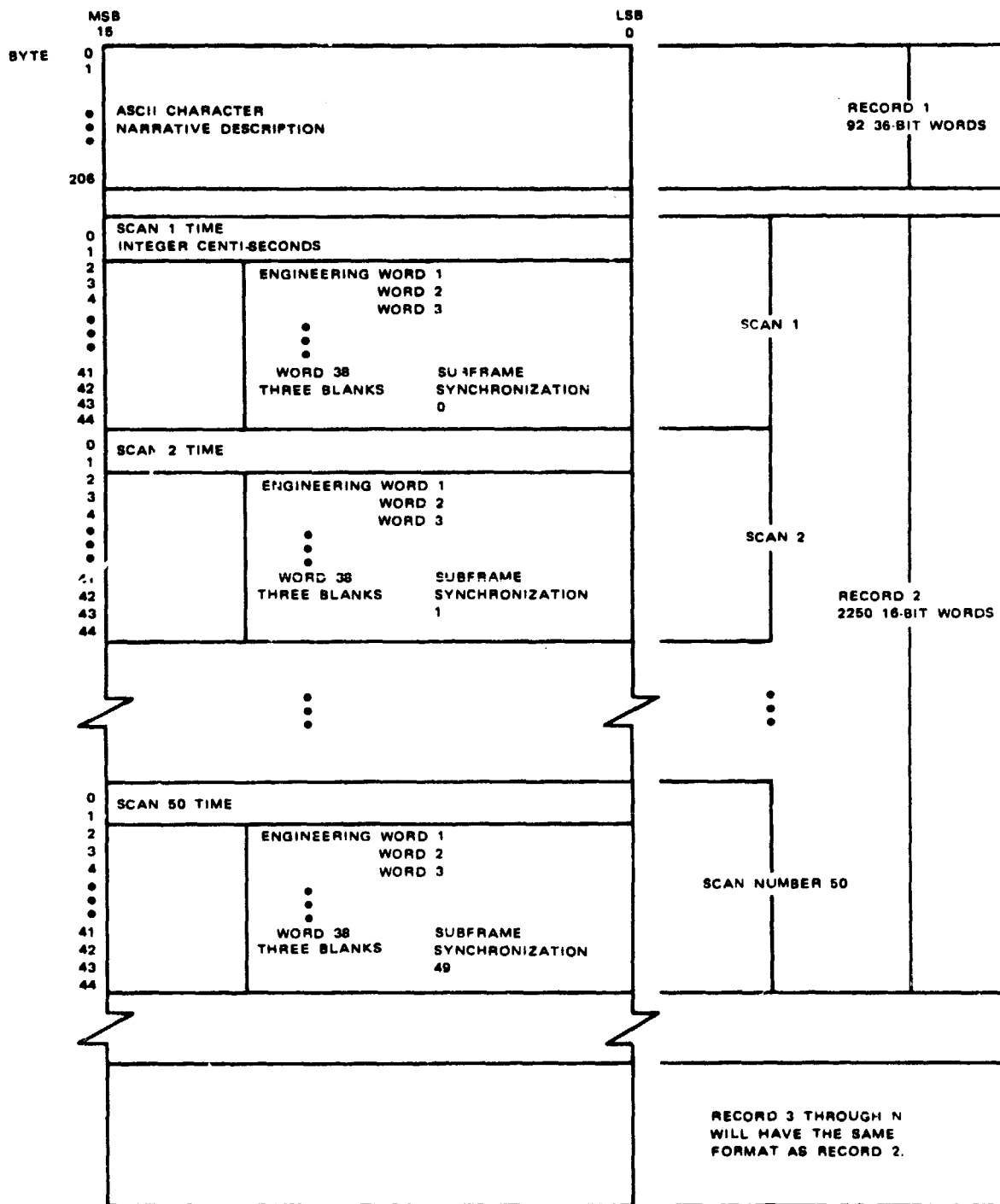


Figure 4-4. - SRL engineering and housekeeping nine-track digital tape format.

- Start and stop times of the data processed
- Input tape parity count
- Indication of the data quality being reformatted.

5. GENERAL TEST APPROACH

The 48-kilobit PCM decommutation program will be tested using a stored-program simulator which will be developed as the data source for the program. The contents of the simulator program will be defined in the design phase.

The reformat program will be tested by separately executing the program option of processing science data and engineering and housekeeping data.

The science data option will be tested by using known data obtained from the decommutation program. Dumps of the output tapes produced from that known input data will be compared to the expected output.

The engineering and housekeeping option will be tested by using input data obtained from BAPS8 runs using simulated input to the BAPS8 program. Dumps of the output tape produced will be compared to the expected output.

6. PRODUCTION IMPLEMENTATION


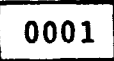
Program operating procedures will be prepared to provide the necessary information to implement the decommutation and reformat programs into production. Existing procedures in the Data Management Plan for the Data Reduction Complex will be updated to incorporate the additional processing requirements.

APPENDIX

ASCII CODE CHARACTER SET

APPENDIX A

Example:



 = A
 b₇.....b₁

	000	001	010	011	100	101	110	111
0000	NULL	DLE	SP	0	e	P	`	p
0001	SOH	DC ₁	!	1	A	Q	a	q
0010	STX	DC ₂	"	2	B	R	b	r
0011	ETX	DC ₃	#	3	C	S	c	s
0100	EOT	DC ₄	\$	4	D	T	d	t
0101	ENQ	NAK	%	5	E	U	e	u
0110	ACK	SYN	&	6	F	V	f	v
0111	BEL	ETB	,	7	G	W	g	w
1000	BS	CAN	(	8	H	X	h	x
100 ¹	HT	EM	)	9	I	Y	i	y
1010	LF	SS	*	:	J	Z	j	z
1011	VT	ESC	+	;	K	[	k	{
1100	FF	FS	,	<	L	\	|	|
1101	CR	GS	-	=	M	]	m	}
1110	SO	RS	.	>	N	^	n	~
1111	SI	US	/	?	O	_	o	DEL



 = 4 Bit Subset

Figure A-1. - American Standard Code for Information Interchange.